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Mount Roraima, State of Roraima

The Sentinel of Macunaíma

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The 2,734-meter high Mount Roraima represents the triple border landmark of Brazil, Venezuela and Guyana. It features the morphologic characteristics of a tabletop mountain or a *tepuy*, whose vertical scarps in excess of 500 meters in height are formed by nearly 2 billion year old sandstones. The base of the mount was first reached by the British expedition led by Sir Walter Raleigh in 1595. The access route to the top by the Venezuelan side is credited to Everard Im Thurn, a botanist, whose expedition reports inspired Arthur Conan Doyle to write his book, *The Lost World*. The mount has an important spiritual meaning for the Macuxi Indians in Brazil who refer to the Mount as the "House of Macunaíma". Geologically, it represents a stratigraphic landmark of the Roraima Supergroup, a paleoproterozoic age sedimentary basin of the Guyana Shield, north of the Amazonian Craton. The Matauí Formation represents the Roraima Supergroup top unit and registers three main sedimentary facies. Mount Roraima remains as an important ecological tourist attraction (trekking). However, it can only be approached from the Venezuelan side, despite the fact that part of it also belongs to Brazil. Hordes of tourist have access the mount annually making the preservation of such a stratigraphic monument necessary as to the maintenance of its pristine state (natural sculptures in rocks) and sedimentary facies abundantly portrayed in sandstone lithologies and indicative of paleoenvironments formed several hundreds million years ago.

Keywords: Mount Roraima. Roraima Supergroup, Matauí, Paleoproterozoic, Guyana Shield.

INTRODUCTION

Mount Roraima (Fig.1) is a sedimentary rocks built up tabletop mountain or a *tepuy* (in the language of the Macuxi Indians), which indicate the triple frontier shared by Brazil, Guyana and Venezuela. Of its overall area, only 5% is found in Brazil, 10% in Guyana and 85% in Venezuela. Important hydrographic basins have their water sources in this location, as it is the case of rivers such as the Arabopó, in Venezuela, the Cotingo in Brazil, and Paikora and Waruma, left-bank affluents of the Mazaruni river in Guyana.

In the Brazilian portion, there is the Mount Roraima National Park, created by the Federal Government as per Decree 97,887 of June 28, 1989 comprising a 116 thousand hectare area. As a park, it has secured by IBAMA – The Brazilian Institute for the Environment and Renewable Natural Resources the full preservation of its flora, fauna and other natural resources keeping its geologic, geomorphologic and scenic characteristics and providing controlled opportunities for visitation, education and scientific research. Its limits are constituted to the west and east, respectively, through the border shared between Venezuela and Guyana. This region is mostly covered by steppic savannah vegetation crisscrossed by rivers and waterfalls where river such as the Cotingo, Caña, Uailã and the Mau are worth mentioning. The northernmost region is covered by Dense Ombrophilic Forest, prevailing over the savannah.

The Canaima National Park in Venezuela sprawling over most of the Roraima and Cuquenán mounts comprise and area of 30,000 sq.km., approximately, larger than the areas of the states of Alagoas or Sergipe, in Brazil.

Roraima is one of the Brazilian states having one of the largest Indian populations in the country. In its northern part it gathers the following ethnical groups: Ingaricó, Taurepang, Patamona, Uapixana and Macuxi. The Ingaricó Indians are concentrated in the upper Cotingo river basin. To the east, towards the border with Guyana and the Mau or Ireng river basin there live the Taurepang, Patamona and Uapixana Indians, and further south, the Macuxi Indians.

The region registers a historical gold and diamond mining activity, which has occupied part of the Cotingo river basin for decades among other important draining activities. However, the mining activity has practically disappeared as of the demarcation and homologation of the Indian Land called "Raposa-Serra do Sol" by the Federal Government on April 15, 2005.

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Figure 1 – (a) View at Mount Roraima. At first plane, the Mount Cuquenán and at background, the Mount Serra do Sol. **(b) R**uinform erosion features in the sediments that sustain Mount Roraima

LOCATION

Mount Roraima is located in the State of Roraima in the northernmost area of the Brazilian territory. Situated in the Pacaraima range, the mount reveals the physiographic characteristics of a tabletop or *tepuy*, whose over 500-meter high vertical slopes are formed by arenitic rocks. Featuring a 2,734.06-meter altitude (IBGE, 2005) it represents the seventh tallest point in the country. In June, 2005, the Engineering Military Institute – IME, the Brazilian Institute for Geography and Statistics – IBGE (Geodesy Coordination) and the First Border Demarcation Committee – PCDL, with head office in Belém, Para State, have carried out an expedition to the Roraima and Caburaí mounts. On the occasion, both the altitude of the Mount Roraima and the determination of the northernmost point of the country were respectively carried out through high precision GPS measurements. The recent altimetry data obtained at Mount Roraima have revealed that this elevation is 5.24 meters less than the previous official value.

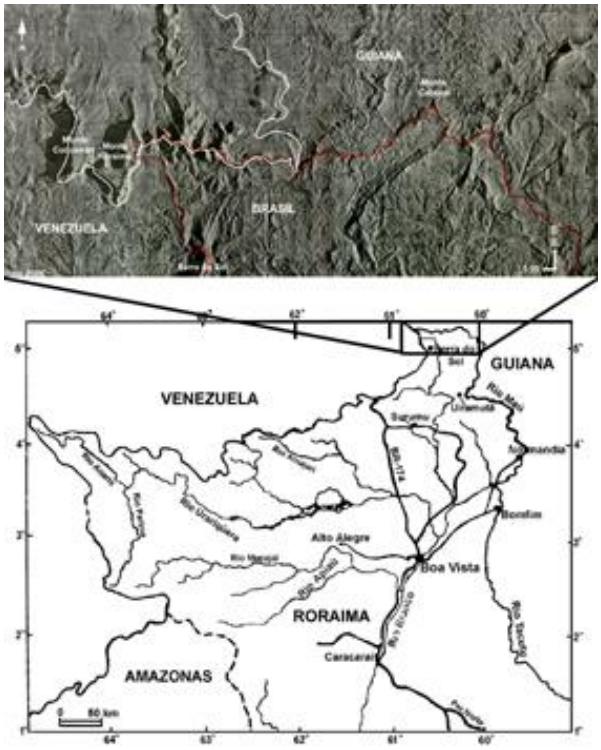

Figure 2 – Location map of the Mount Roraima and surrounding areas at the northernmost portion of the State of Roraima. At the radar image the red line represents the frontier between the three countries and the white line represents the area of the Matauí Formation, Roraima Supergroup

The highest point at Mount Roraima is the Maverick Stone, where the border landmark between Brazil and Venezuela (BV-0) is located. The summit comprises a 31 sq.km. area, approximately, whose leveling surface is found around the 2,500 meters. Residual rocky elevations of varying dimensions and normally isolated occur above the leveling surface. The highest elevations are situated further north of the mount.

The geographical coordinates of the border landmark, with datum in SAD 69, are: 05°12'13.57" N and 60°42'55.08" W. It is contained on the southwest in the Sheet NB.20-Z-B-V 1:100.000 scale).

It is situated at approximately 50 km to the west of Mount Caburaí (1,456 m), the northernmost point in the country (05°17'19,77" N and 60°11'54,51" W). To the east, in the Venezuelan territory, it is found near Mount Cuquenán. To the southeast, through the border line, it is some hundred meters away from the Uei Tepuy ("Serra do Sol") (2,110 m) (Fig. 2).

HISTORICAL BACKGROUND

Mount Roraima was first climbed in 1595 by the British expedition led by Sir Walter Raleigh. According to other sources, Raleigh would have arrived just at the base of the mount, however, he compiled enough material to write the work he would denominate "Crystal Mountain". Through the western side, his feat owes much to botanist Everard Im Thurn who revealed the access route by the Venezuelan side. The reports of such expedition inspired the English Arthur Conan Doyle – the acclaimed creator of detective Sherlock Holmes – to write the book "The Lost World".

The State of Roraima registers since the outset of the XVII century the dispute for its land by the Spaniards, the Portuguese, the Dutch and the British. Part of its territory has already been under the possession of the former British Guyana, today the Cooperative Republic of Guyana. Territorial disputes have led the Royal Geographical Society of London to send the geographer Robert Schomburgk to map the British Guyana, in 1838, at the request of the British Crown. On the occasion, he plotted Mount Roraima. In 1943, the Brazilian Government created the Rio Branco Territory, dismembering it from the State of Amazonas. In 1962, the name of Roraima was given to the territory and in 1988, upon a decision by the Constituent National Assembly Roraima became a State of the Federation. Mount Roraima, in turn, is part of the municipality of Pacaraima (ancient BV-8), whose emancipation took place as per State Law No. 96 of October 17, 1995. At the time of creation of the municipality, the Pacaraima settlement was part of the "São Marcos" Indian Land.

Mount Roraima has an important spiritual meaning for the Pemón Indians in Venezuela and the Macuxi

Indians in Brazil. It is respectively referred to as the "mother of all the waters" and "house of Macunaíma". The legend thus say that: "there was a very high mountain in the Roraima lands where a crystal-clear lake was the witness of the sad love between the Sun and the Moon. For obvious reasons, the two beloved had never had the opportunity to meet to live that love. Whenever the Sun would rise in the horizon, the Moon would set, and vice-versa. It had been so for millions and millions of years. One day, however, nature set up an eclipse to allow the two to meet, at last. The plan succeeded. The Moon and the Sun met in the sky. The skirts of light from the sun around the moon reflected on the waters of the crystal-clear mountain lake and impregnated its waters bringing to light Macunaíma, the Mount Roraima joyful Indian boy. As time went by, Macunaíma grew up and became a warrior among the Macuxi Indians. Very close to Mount Roraima there was a tree called "Three of all Fruits" as it simultaneously yielded bananas, pineapples, tucumãns, açaís and all the delicious fruits that existed. Only Macunaíma was authorized to harvest the fruits and to equally distribute them among his people. But nothing could ever be so perfect. Some moons were to pass until ambition and envy would take hold of the hearts of some in the tribe. Some more inconsequent Indians went up the tree, stripped away all the fruits and broke several branches in order to plant them and have more trees like that one. The large "Tree of all Fruits" died and Macunaíma had to punish the evildoers. The hero set the whole forest on fire and turned every tree into a rock. The tribe panicked and everybody had to flee. It is said, today, that the spirit of Macunaíma lives in the Mount Roraima crying over the death of the "Tree of all Fruits".

Mount Roraima remains as an important attraction for trekking (Fig. 3). This, however, is only possible by the Venezuelan side, whose slopes have been smoothed out by a wide colluvium zone caused by the erosion of the referred arenitic rocks. The eastern slope, in the Brazilian territory was climbed by three Brazilian alpinists only in 1991.

SITE DESCRIPTION

In the field of geological research, various pioneering studies were carried out in Mount Roraima. To cite only a few: Tate (1930), Paiva (1939) and Gansser (1954). The original lithostatigraphic term "Roraima" was proposed by Dalton (1912) in referring to the sandstones as Roraimã or "Kaiteur". The name "Kaiteur" had been introduced by Anderson & Dunn (1895) to characterize a conglomeratic level present in the Kaiteur waterfalls, Guyana.

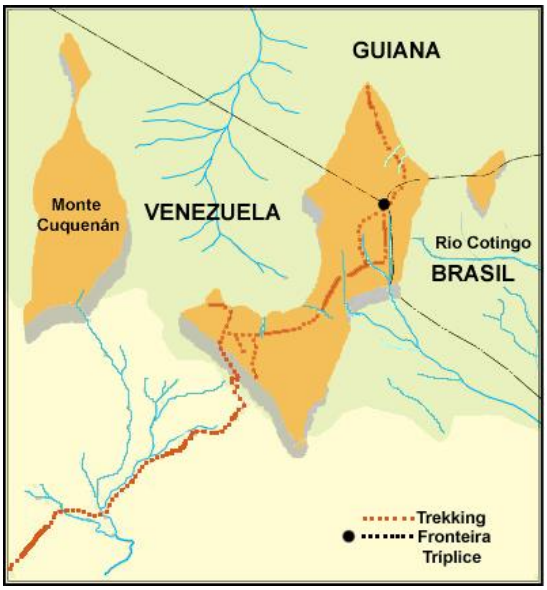

Figure 3 – Location map of Mount Roraima at the frontier between Venezuela, Guiana and Brazil showing the trekking trail to its top

Mount Roraima represents a sedimentary unit of the summit of the Roraima Supergroup (Reis, *et al.*,, 1998; Reis & Yánez, 1999, 2001), denominated by Reid (1972) as Matauí Formation. According to this author, the formation is, also, found in the Cuquenán, Yuruani, Ayantepuy and Ueitepuy mounts, in the Venezuelan territory. The Roraima Supergroup, whose formation have been deposited throughout the Orosirian period of the Paleoproterozoic Era, reveal maximum and minimum ages respectively established in 1.95 and 1.78 billion years (cf. Reis *et al.*, 2000, 2003, 2005; Santos *et al.*, 2003).

Near the base of the mount, there occurs a basal rock sill, the fourth of the about 2,900 meters thick whole sedimentary succession of the Roraima Supergroup. Such dolerite sill has been informally denominated as "Mount Roraima" (Reis *et al.*, 1990a; Reis, 1990), partly covered by a colluvium zone. Tate (1930) described greenish jaspers (in fact, cineritic tuffs) on the sides of such rocks, revealing, by this way, the proximity of the contact with the Uaimapué underlying unit (Reis & Yánez, 2001).

The Roraima Supergroup sprawls over a continuing area of about 73,000 sq.km. having being denominated as Pacaraima Sedimentary Block by Reis & Yánez (1999). The volcanic substrate of the Roraima Supergroup, also common to the three countries, has received different geologic designations – Surumu (Brazil), Iwokrama/Dalbana (Guyana) and Cuchivero (Venezuela). The Roraima basin is possibly related to a N-S general extensional event, responsible for the development of normal E-W faults and transference

faults. The basin experienced a weak positive inversion involving the reactivation of normal upthrow faults, where the transfer faults worked as lateral ramps. In the proximity of the E-W faults, the supergroup reveals echelon folds, however, towards the center of the basin, only a gentle deformation of its rock units is recorded, which led to the preservation of its primitive stratigraphic relationships (Pinheiro *et al.* 1990).

The Matauí Formation has been described by Pinheiro *et al.* (1990) as made up of a succession of fine to very fine arkosean sandstones, medium to coarse arenitic quartz, conglomeratic and conglomerate sandstones. The access to the study area was get by the authors by means of a helicopter. A thickness of about 440 meters was estimated for the formation. In addition, there are at least more 160 meters of vertical cliffs and talus at the base of the mount.

Three main sedimentary facies which portray the depositional paleoenvironments of the lithologies of the Matauí Formation were proposed: tidal to shallow marine, aeolian and fluvial facies (Fig.4).

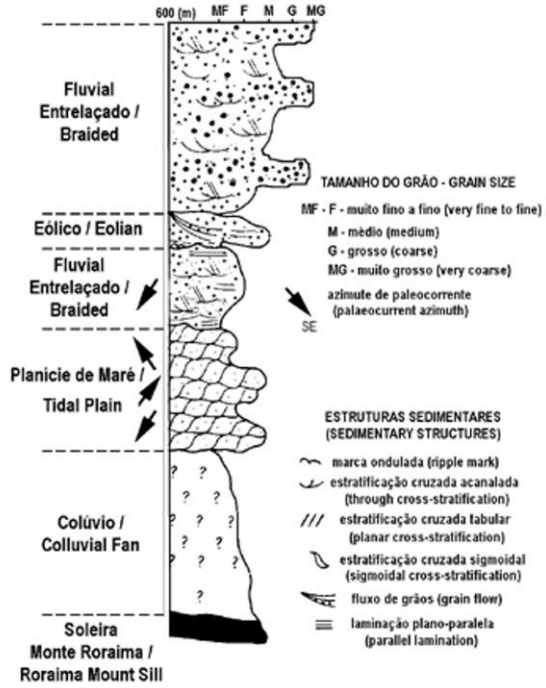

Figure 4 – Schematic section of the Matauí Formation, Roraima Supergroup at Mount Roraima Mount (modified from Pinheiro et al., 1990)

Upward from the top of the colluvium zone, the base of the Matauí Formation is represented by a set of fine to medium sandstones, mostly bleached and rich in bidirectional cross-stratification with paleocurrents azimuth for SW and NE quadrants. A tabular to sigmoidal geometry is displayed (Fig. 5 and 6). The measured package is approximately 120-meter thick.

In a overlying position, the following is observed: well selected medium, pink sandstones with large-size cross-stratification (> 1,0 meter), low angle foreset and paleocurrent azimuth to 260º. They were interpreted as aeolian dune deposits, possibly deposited near the intermediate zone between the sea and the continent. A thickness around 60 to 80 meters is estimated.

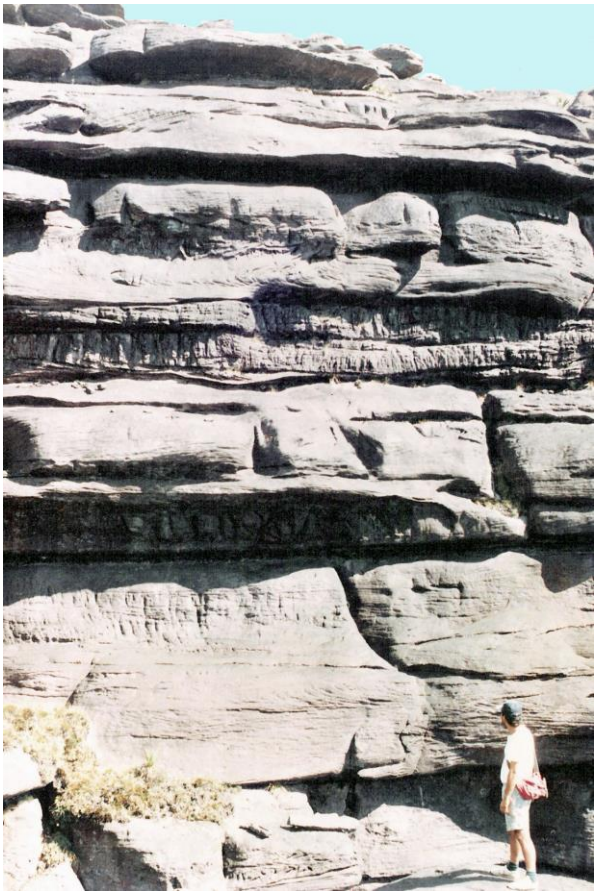

Figure 5 – Quartz and arkosean sandstones of about 8 meters thick, containing tabular geometry, parallel lamination and cross-stratification. Top of Mount Roraima.

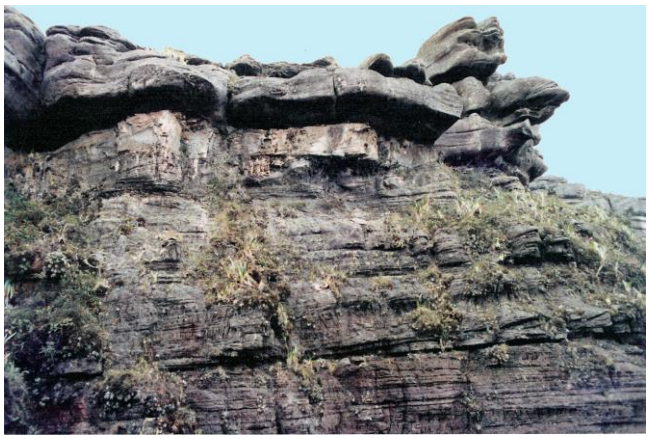

Figure 6 – Arkosean sandstones with paralell lamination and cross-stratification. Top of Mount Roraima.

Fine and very fine cream-colored quartz-like sandstones with tangential and parallel cross-stratification respectively in 2.0 and 0.80- meter sets are overlain. In the interface between the sets there appear around 8.0 cm thick fine clay-like, dark red levels and whose top part there are signs of nonbifurcated assimetric wave marks. Such strata are those which show less resistance to the process of erosion forming, thus, entries in the neighborhood of the underlying and overlying sandstone strata. Such processes have led to the formation of some caves. They exhibit a variable thickness of around 8 to 20 meters exposing vertical scarps (Figs. 6 and 7). It is admitted that the set of plane-parallel strata have been generated at the interdune zones.

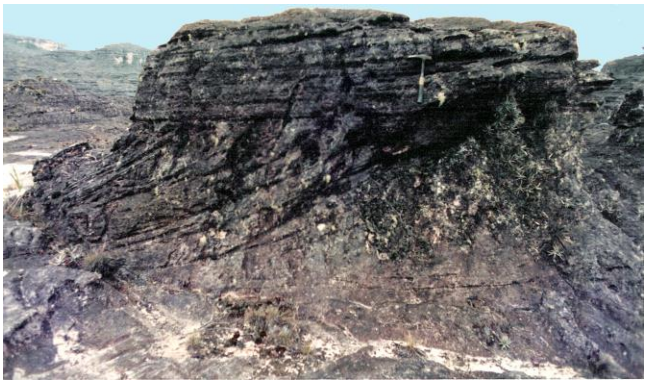

Figure 7 – Through Cross-Stratification in arkosean sandstone from Matauí Formation, Roraima Supergroup. Top of Mount Roraima.

The top succession is represented by medium to coarse granulation, conglomeratic and conglomerate sandstones, the latter in the shape of lentils. The conglomeratic levels rest on the base of large-sized cross-strata. Upwards, the cross-stratification that has developed into coarse sandstones exhibit festooned forms. The maximum thickness of the package has been calculated at around 250 meters.

Regarding the Matauí Formation, other authors have revealed two major depositional environments: high energy fluvial (Reid, 1972) and coastal with wave actions (Ghosh, 1981). The estimated thickness for the Matauí Formation ranges from 600 to 780 meters.

The Matauí Formation terminates the Roraima Supergroup deposition cycle, representing the register of the final marine regression over the so called "Verde Sea", recalling to the marine sedimentary rocks in the Verde Formation of the Suapi Group (Reis *et al.*, 1990b).

The Roraima basin registers lithostructural products related to tectonic subsidence (with magmatic contribution) and thermal phases. The Matauí unit developed in a relatively short period under of high stability and represents the major products of the thermal phase (Costa, 1990.

MEASURES OF PROTECTION

Since the geological site is within an area of important ecotourist interest, a target of periodic excursions (*trekking*) both nationally and internationally, the following actions are suggested:

1. to make bilingual (Spanish and English) information signs related to the site, highlighting its importance as a paleoproterozoic sedimentary witness of the Guyana Shield dating hundreds of millions of years;
2. to prohibit acts of disfiguration of its rocks and surrounding environment, through varied writings and depredation;
3. to prohibit the pollution of its crystal-clear waters since they constitute the natural watershed for major rivers flowing towards Brazil, Guyana and Venezuela, corroborating with the name assigned to it, namely the "mother of all the waters";
4. to prohibit the building of dwellings and leisure projects which may lead to the descharacterization of its summit.

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